THE SCALES OF SOME QUEENSLAND FISHES.

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I am greatly indebted to Dr. R. Hamlyn-Harris for a very interesting series of scales of the fishes of Queensland. They not only belong to species, the scales of which have not been studied according to the methods of modern lepidology, but they are of interest as enabling us to see whether the fishes of the Southern Hemisphere differ markedly in scale characters from their allies in the North.

OSTEOGLOSSIDÆ.

Scleropages leichardti Günther. The large scales are reticulated and have beaded circuli, in the typical Osteoglossid manner. The structure of the scale is quite the same in *S. leichardti* from Queensland, *S. formosus* from Borneo, and *Osteoglossum bicirrosum* from Brazil, notwithstanding the wide geographical separation of these fishes. (*See also* Science, May 26, 1911, p. 831.)

HEMIRHAMPHIDÆ.

The scales in this family are much broader than long; nucleus central or nearly; apical margin simple; basal margin frequently lobulate; apical field covered with very fine and dense transverse circuli; basal half of scale with much more widely spaced circuli, which bend upwards laterally, and meet the circuli of the series above the nucleus, forming angles (often very acute angles) with them. Two or three basal radii are nearly always developed.

The Queensland species may be separated thus:—

Scales (which have a transverse diameter of 12 mm. or over) with very prominent basal lobes	*Hemirhamphus far* Forskal.
Scales without such basal lobes	1.
1. Scales with the circuli of the upper and lower halves regularly meeting at sides, forming acute angles ..	*Hemirhamphus quoyi* Cuv. & Val.
Scales with the circuli of the upper and lower halves not regularly meeting, usually separated at sides by a space free from circuli	*Hemirhamphus regularis* Günther.

One of the *H. quoyi* scales, apparently from the lateral line, has a large obtuse apical lobe. The species are not separated by very marked characters, and probably intermediate scales will be found. Indeed, the constancy of the type is shown by the fact that *Hyporhamphus unifasciatus*, from Woods Hole, Mass.

(U.S. Bureau of Fisheries), and Balboa, Panama Canal Zone (Meek and Hildebrand, U.S.N.M.), has scales which differ very little from those of *Hemiramphus quoyi,* though occasionally nearly as well lobed basally as *H. far.* Young scales of *H. unifasciatus* (and doubtless also of the species of *Hemirhamphus*) show the apical area without circuli, and the dense transverse circuli begin to form close to the line where the lower ones end.

It remains to be noted that, in addition to the features described, there is a minute sculpture which seems to be due to the cracking of the surface of the scale. In *H. unifasciatus* it takes the form of series of very fine lines which are usually more or less curved, and form semispiral systems which often cross, giving rise to a minute reticulation. In *Hemirhamphus quoyi* these lines are less frequent, and cross the fine circuli at right angles. In *H. regularis* there is produced a fine irregular reticulation between the circuli. In *H. far* there is often a much coarser and extremely irregular reticulation extending across the middle of the scale.

Cypsilurus scales (six species examined) are of the same general type as those of the Hemirhamphidæ, but less extreme, with the circuli usually vertical at the sides, and those of the upper and lower halves of the scale not widely different.

ATHERINIDÆ.

Scales of *Atherina* are longer than broad, with very prominent laterobasal angles and more or less straight sides. The apical margin is thin and without teeth; the basal margin is more or less prominently lobulate. There are no basal radii, but ray-like grooves or channels often extend upwards, gradually fading, from between the basal lobules. The basal half of the scale has fine transverse circuli, much as in Hemirhamphidæ, but the apical half is wholly without circuli, thus recalling the young of *Hyporhamphus unifasciatus.* There are very fine irregular lines due to cracking, as in the Hemirhamphidæ.

I have not seen enough material to be sure of the specific characters of the Queensland species, but they are apparently separable thus:—

Scales comparatively large, much broader than long, with about three very abrupt and prominent lobes close together at the middle of the straight basal side	*Atherina pinguis* Lacép.
Scales smaller, not so broad, not trilobed in middle of base	1.
1. Median basal lobe very prominent	*Atherina lacunosa* Forster.
Median basal lobe low and broad, not prominent	*Atherina honoriæ* Ogilby.

Atherina stipes Müller and Troschel, from Toro Point, Panama Canal Zone (Meek and Hildebrand, U.S.N.M.), has entirely the same generic characters in the scale. It is practically as in *A. pinguis,* the base trilobed, varying to two or one lobed. Occasional scales of both species are more or less clearly multilobed; this is especially to be noted in *A. pinguis.* One scale of *A. honoriæ* shows a strongly lobulate or scalloped apical margin, which is a regular character of *Kirtlandia laciniata* and *Chirostoma crystallinum.*

Atherina scales differ from those of the other Atherinidæ studied—namely, *Atherinops, Kirtlandia, Chirostoma,* and *Menidia*—in the absence of circuli in the apical field, and of basal radii.

MUGILIDÆ.

Scales of *Mugil* are semicircular, or rather represent somewhat more than a half-circle, with a straight or nearly straight base. The genus *Liza,* which I had not before seen, differs at once by the quadrate scales, with straight sides, although the apical margin is rounded as in *Mugil.* The *Liza* scales before me are light green, perhaps owing to some peculiar condition of preservation.

Comparing the scales of *Mugil georgii* Ogilby, from Queensland, with those of the American *M. curema* C. & V., I find some marked differences, as follows:—

Ctenoid area largely developed, interrupting the circuli apicad of the nucleus; basal radii close together, subparallel or converging toward the margin .. .. *M. curema.*

Ctenoid area poorly developed, at least in some scales, so that many circuli may cross the apical field; basal radii (seven or fewer) diverging from the nuclear region, arranged in a fan-like manner .. .. *M. georgii.*

The matter of the ctenoid area is not to be taken very seriously, as *M. georgii* scales differ greatly: but the difference in the radii appears to be important, and indicates that *M. georgii* has the more primitive type of scale.

Mugil trichodon Poey, from Honduras (C. H. Townsend, U.S.N.M.), has scales very like those of *M. curema,* but with distinct laterobasal angles (these are obtusely rounded in *curema*) and the basal radii (except the middle ones) more spreading, but very irregular and unlike those of *M. georgii.* The laterobasal angles of *M. georgii* are as in *M. trichodon.* The *M. trichodon* scales differ from both the others in having a straight median groove running from base to apex, though not entering the broad papery apical margin, which is in a sense distinct from the scale proper.

The *Liza* scales are large, with extremely fine circuli, and radiating basal radii (5 or 6) like those of *M. georgii.* In the apical field the circuli are broken up into very fine irregular tubercles; in *L. splendens* de Vis (at least in the two scales before me) there is no ctenoid area at all; but in *L. waigiensis* Quoy and Gaimard the tubercles are seen to directly pass into dentiform ctenoid structures close to the margin, the teeth so formed being triangular, with a strong median ridge representing the original tubercle.

In *L. splendens* there is a thin papery apical fringe, as in *Mugil,* but it is crenate-margined, and divided by radial lines, which slightly enter the substance of the scales. In both species there may be a rather irregular transverse radial line, crossing the middle of the scales but not reaching the extreme sides. In both, the laterobasal angles are practically right angles. The dimensions are—*L. splendens,* length 13, breadth 11½ mm.; *L. waigiensis,* length 11, breadth 10 mm.

HOLOCENTRIDÆ.

Holocentrus angustifrons Ogilby, from Queensland, has scales about 5½ mm. long and 8 broad, the apical margin with strong straight teeth; the sides sloping to the very broad base, the laterobasal angles therefore extremely prominent; the straight base with about four lobules, the ends of longitudinal ribs, near the middle. Circuli very fine, failing apically; region below the nucleus more or less pustulose. Except that the laterobasal corners project more, these scales agree with those of *H. diadema* Lacép., from Hawaii. The scales of the species of *Holocentrus* are on the whole very uniform.

PEMPHERIDÆ.

Pempheris multiradiatus Klunzinger. Scales of three sorts; it is noted on the label, "breast scales ctenoid." Scales broader than long, with a diameter of 3 to 4 mm. *Normal cycloid scales* broadly rounded apically, with a nearly central nucleus from which proceed, in a radiating manner, about five very distinct basal radii; basal margin deeply scalloped; laterobasal angles obtuse; basal half of scale with fine circuli, but these are absent from the apical field, which exhibits only growth lines. *Lateral line scales* are broader, and are without the basal radii and basal scallops; the basal margin is convex in the middle and concave sublaterally. The lateral line canal has a very broad bilobed appendage. The *ctenoid breast scales* are very different from the others, quadrate, with straight sides, but broader than long, the apical margin with numerous strong straight teeth. The basal radii and scallops are as in the first type of scale described. There is no ctenoid patch; the marginal teeth are exactly like those of *Holocentrus.*

I have scales of *Pempheris* (*? otaitensis*) from the Red Sea, which resemble the normal cycloid type described above, but are considerably broader, with the circuli continuous across the apical field.

Neopempheris ramsayi Macleay. Scales apparently *all* ctenoid, with a very well developed ctenoid patch. Scales about 3 mm. diameter, somewhat broader than long, subquadrate, nucleus a little above the middle; four or five very strong basal radii or folds, and basal margin very strongly scalloped; circuli very fine; ctenoid structure consisting of rows of elongate teeth. The apical teeth are much as in *Mullus*, but their bases are broadened, and the whole ctenoid area is confused, not beautifully distinct in all its details as in Mullidæ.

There is nothing in the scales of Pempheridæ to suggest assoeation with the genus *Beryx*. *Pempheris*, however, strongly suggests *Holocentrus*. *Pempheris* is so different from *Neopempheris* as to suggest two distinct subfamilies, Pempherinæ for the first and Neopempherinæ for the second. *Bathyclupea* is separated by Jordan as a family Bathyclupeidæ.

CHEILODACTYLIDÆ.

Cheilodactylus nigricans Richardson. Scales subquadrate, broader than long, about 5 mm. long and 5½ broad; basal radii numerous (about 16); laterobasal corners very obtuse; nucleus a little above middle; circuli very fine and dense; a few circuli crossing above the nucleus, but most of the lateral circuli come to an end above, first curving slightly *outwards*. The scales are not at all ctenoid, and the apical field (covered with dark skin) has a pustular or perforate structure, somewhat suggestive of *Beryx*. *C. variegatus*, from Peru (P. O. Simons, U.S.N.M.), has similar scales, but larger, with the pustules larger in proportion, and not circular. It is clearly seen, in this species, that they represent broken-up apical circuli.

SERRANIDÆ.

Epinephelus estuarius Macleay, or **E. megachir** Rich. (the first name is on the list sent, but the second on the label of the specimens) has greatly elongated, parallel-sided scales, about 8 mm. long and 4 broad, with only a small apical portion covered by the black skin. The nuclear area is greatly elongated, extending down the middle of the scale, and consequently the strong basal radii, arranged fanwise, 8 or 9 in number, begin below the middle of the scale, often far below. The basal margin is crenate. The ctenoid patch is very well developed, and the marginal teeth are broadened at the end, and truncate. These scales differ from those of *E. niveatus* (Cuv. & Val.) by the proportionately smaller and truncate teeth, and especially by the elongated nuclear area; but my examples of *E. niveatus* are probably young. The scales of *Epinephelus* closely resemble those of *Paralabrax*, but those of the latter are less elongated. The scales of *Centropristes, Morone, Roccus, Percichthys,* and *Plesiops* are not elongated.

LUTIANIDÆ.

Lutianus sebæ Bloch. Scales subquadrate, about 12 mm. long and broad; laterobasal corners rounded; about 20 strong basal radii; ctenoid patch very distinct, apical teeth pointed, sometimes slightly bifid at end; submarginal elements like short phalanges.

Lutianus johnii Bloch. Scales about 5½ mm. long and broad; basal radii 9 or less; ctenoid structures as in *L. sebæ*. These scales are perhaps immature. In general, the two species agree very closely in their scales, and also agree nearly with *Neomænis griseus* (L.) from Tampa, Florida. The *Neomænis,* however, has more than twice as many basal radii as *L. johnii,* in scales of about the same size. The *Neomænis* has minutely beaded basal circuli, and both the species of *Lutianus* show exactly the same feature.

The scale of *Kuhlia rupestris* C. & V. (Kuhliidæ), from Mauritius, is extremely like that of *Lutianus,* except that it has more prominent laterobasal angles, and the submarginal elements of the ctenoid patch are somewhat longer. They are distinguishable, but from the scales alone I should have supposed them to be closely allied members of one family.

SPARIDÆ.

Pagrosomus auratus Forster. Scales about 19 mm. long and 21 broad; subquadrate, with convex (bulging) sides, and crenate lower margin; nucleus above the middle; about 9 distinct basal radii, arranged fanwise; basal circuli minutely beaded; ctenoid patch large, but the elements mostly ill-defined, those near the margin distinct, and very short, some broader than long; marginal teeth sharply pointed. Sparsely scattered over the ctenoid patch are black dots or minute streaks, which appear under the compound microscope to be little canals with round openings. This last feature strongly suggests the perforations of the same region in *Beryx.*

Sparus sarba Forskal. Scales reddish, very broad, about 7½ mm. long and 10½ broad; basal radii about 14, widely spreading. Structure as in *Pagrosomus,* but shape different.

Lethrinus harak Forskal. Scales about 6½ mm. long and broad, thus differing from *Pagrosomus* in the opposite direction from *Sparus.* Basal radii about 15. Structure as in the other genera, with the same scattered perforations in the ctenoid area; but the subapical ctenoid elements are quite different, being elongated, consisting of a stick-like central rib, with a margin of nearly equal width on each side of it.

I find that the scales of *Dentex vulgaris,* from England, show scattered perforations in the ctenoid area, just as in the Australian Sparidæ. The ctenoid patch of *Dentex* has a honeycomb-like pattern.

THERAPONIDÆ.

Therapon jarbua Forskal. Boulenger lists *Therapon* as a genus of Lutianinæ. The scales are subquadrate, longer than broad; length about 2½ mm., breadth about 2; sides parallel; laterobasal corners rectangular; nucleus above middle; about 9 strong basal radii; lower margin scalloped; basal circuli minutely beaded; lateral circuli rather coarse; ctenoid patch well developed; apical teeth sharp; subapical elements of ctenoid patch short; the ridge or keel running down the teeth is continued on to the elements below, so that the ctenoid area presents a series of radiating ridges.

These scales do not closely resemble those of *Lutianus*. They are also unlike the scales of the Sparidæ. They do, however, quite closely resemble the scales of *Paralabrax*.

KYPHOSIDÆ.

Kyphosus cinerascens Forskal. Scales subquadrate, broader than long, a large one about 8½ mm. long and a little over 10 broad; 7 to 9 strong basal radii; basal margin scalloped; basal circuli finely beaded; ctenoid patch well developed; marginal teeth sharp; submarginal elements of ctenoid patch longer than broad, broadened at base. The lowermost part of the skin-covered area shows coarse irregular dendritic markings, consisting of ridges which are directly connected with those of the ctenoid patch, leading to the marginal teeth. The scales of *Kyphosus sectatrix* (L.), from Massachusetts (Menemsha Bight), are somewhat modified from this type, but the essential generic characters are quite the same. The thickened perforated band which crosses the middle of the scale of *K. sectatrix* is rather indistinctly indicated in *K. cinerascens,* representing in fact the denser basal part of the dendritic area.

SILLAGINIDÆ.

Sillago maculata Quoy and Gaimard. Scales subquadrate, broader than long, about 3 mm. long and 3½ broad; *nucleus subapical*; seven or eight very distinct basal radii, spreading fanwise; basal margin scarcely at all scalloped; laterobasal corners rectangular; only about every third of the basal circuli continued to the sides, the lateral circuli consequently widely spaced; marginal teeth very sharp; ctenoid patch a mere narrow band, with only about two distinct elements below the teeth (at the sides one or none), these very short and broad.

These scales suggest those of the Gobiidæ, which are, however, of a more extreme type. In *Ctenogobius virgatulus* (Jordan & Snyder), from Japan, I find the basal circuli, many of them, stopping short at the beginning of the lateral field. There is a close resemblance between the scales of *Sillago* and those of some Sciænidæ, in which the nucleus is far toward the apex. A very good example is found in *Menticirrhus saxatilis* Bl. & Schn., from Woods Hole, Massachusetts. Boulenger remarks that the Sillaginidæ connect the Serranidæ with the Sciænidæ. The scales suggest that the affinity is closest with the Sciænidæ.

POMACENTRIDÆ.

Glyphisodon palmeri Ogilby. Scales subquadrate, broader than long, a large one about 8 mm. long and 8½ broad; about 8 or 9 strong basal radii; basal margin scalloped; circuli extremely fine; ctenoid area well developed;

marginal teeth sharp; below the ctenoid area is a broad region covered with reticulations and dendriform markings, obviously consisting of modified circuli, and connecting at sides with the lateral circuli. The canal of the lateral line scales has some irregular branches at its apical end. The submarginal elements of the ctenoid patch are much longer than broad.

This scale is in all respects very similar to that of *Abudefduf saxatilis* (L.), from Sorocco Island, but the *Glyphisodon* scales can be distinguished by the conspicuously developed reticulated or dendriform area, the marking of this region in the *Abudefduf* being minute and labyrinthiform. *Abudefduf* has also broader scales than *Glyphisodon*, while those of *Eupomacentrus leucostictus* (Müll. & Trosch.) are much broader than those of *Abudefduf*.

LABRIDÆ.

Chœrodon venustus de Vis. Scales subquadrate, about 17 mm. long and 15 broad; basal radii very numerous, about 36, many ending on the lateral margins; basal margin hardly at all scalloped; circuli (lateral and basal) extremely fine; apical margin thin, not ctenoid, with numerous fine longitudinal radii.

Pseudolabrus gymnogenis Günther. Scales similar in form to those of the last, about 16 mm. long and 14 broad; structure also as in the *Chœrodon*, except that the broad nuclear region is covered with irregular reticulations, which are only weakly developed in the *Chœrodon*.

In *Chœrodon*, the very numerous apical radii have the appearance of widely spaced circuli, and with a lens appear to be actually continuous at the sides with the lateral circuli. The compound microscope shows that this is not really the case; and in *Pseudolabrus* the apical lines are directly continuous into the reticulated patch, which on the other side is continuous with the basal radii. The whole, therefore, belongs to the radial system.

Eupetrichthys angustipes Ogilby. Scales parallel-sided, longer than broad, but not greatly so; length about 6 mm.; basal margin convex, not scalloped; basal radii about 25, of which about four on each side end on the lateral margin; apical radii well developed, no closer than the basal, and hence very different from those of the other two genera described above. No reticulated discal area. Lateral line canal with numerous stout branches at the apical end, each ending in a perforation of the minutely spotted skin, and having one or more smaller round perforations in its course. (Compare Günther's figure of the scale of *Labrichthys*.)

All these scales have the form and structure characteristic of the Labridæ. Those of *Chœrodon* and *Pseudolabrus* are in general much like those of *Iridio bivittatus* Bloch, from Key West, Florida, and *Tautogolabrus adspersus* (Walb.);

but *Iridio* has the apical radii more widely spaced, while *Tautogolabrus* has them almost entirely obsolete.

The scales of *Eupetrichthys* are very like those of *Emmeckia venusta* (Jenkins & Evermann), from the Gulf of California.

GOBIIDÆ.

Hypseleotris compressus Krefft. Scales about 2½ mm. long and 3⅓ broad, of perfectly typical Gobiid type, with the nucleus subapical, the apical margin (except in latinucleate scales) raised and roof-like in outline, &c. The structure is as in the Japanese *Ctenogobius virgatulus,* but the middle of the apical margin is less elevated. Gobiid scales, wherever they come from, are very characteristic, and very much alike.

NOTOTHENIIDÆ.

Parapercis cylindrica Bloch. Boulenger places this in the Leptoscopidæ; I follow the labelling of the Queensland Museum. Scales subquadrate, a little broadened basally; length and breadth about 2 mm.; nucleus not far from apex; basal radii about ten, strong, spreading; basal margin weakly scalloped; basal circuli very dense; lateral circuli much fewer and coarser; apical teeth large and sharp; subapical ctenoid elements well defined, broader than long, about four rows distinct.

It is a singular thing, that the ctenoid features of this scale, including the submarginal elements, *exactly* agree with those of certain Percidæ, as for example *Hadropterus peltatus,* from North Carolina. The whole scale is, in fact, very like that of Percidæ. On the other hand, the scales of *Parapercis* are not very unlike those of the Scorpænid genus *Sebastodes,* from California.

It will be seen from all of the above, that the scales of Southern fishes closely resemble those of their Northern relatives. On the whole, the present paper serves strongly to confirm the validity of scale characters, showing that family and generic characters hold good over the world.